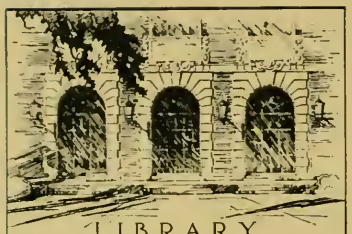

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THE

UNCERTAINTIES

OF

MODERN PHYSICAL SCIENCE.

BEING

THE ANNUAL ADDRESS

OF THE

Victoria Institute, or, Philosophical Society of Great Britain,

Delivered at the House of the Society of Arts, on the 29th May, 1876.

BY

THE REV. CANON BIRKS, M.A.,

Knightbridge Professor of Moral Philosophy, Cambridge.

TO WHICH IS ADDED

THE REPORT FOR THE YEAR, &c.

FOURTH EDITION.

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SUMMARY OF THE PROCEEDINGS AT THE TENTH ANNUAL MEETING OF THE VICTORIA INSTITUTE, HELD AT THE HOUSE OF THE SOCIETY OF ARTS, 29TH MAY, 1876.

1st Resolution.—The adoption of the Report. Moved by J. E. HOWARD, Esq., F.R.S.; Seconded by ADMIRAL NOLLOTH, R.N.

2nd Resolution.—The vote of thanks to the Council and Honorary Officers.

The Right Rev. BISHOP RYAN, D.D., in moving this resolution, said the publications of the Institute had done a very large amount of good in combating the infidelity which was, unfortunately, too prevalent at the present time, arising from erroneous views as to the true results of scientific discovery, and from the rash adoption of such pseudo-philosophical and quasi-scientific theories as tended to undermine the belief in revealed religion; and so also had the lectures; and argued that such a central society for the defence of Christianity was of paramount importance at the present time, and referred to the comparatively small cost at which the Society accomplished its work, the average of the item for salaries for the last five years having been at the rate of £38 per annum.

Mr. MARK J. STEWART, M.P., seconded the resolution and alluded to the zealous and pleasing manner in which the executive always carried on the work of the Institute, and called attention to the fact that the Transactions of the Institute had been extensively circulated on the Continent, in the United States and the Colonies, and now even among the peoples of India.

The Right Honourable STEPHEN CAVE, M.P., regretted that his duties at the House of Commons had prevented him being in time to move the first resolution; he would, however, ask permission to support this one. (Cheers.) In doing so he paid a tribute to the "energy, zeal, tact, and discretion" exercised by the honorary officers. He stated that he agreed with every word which had been spoken by the previous speaker as to the good which had been effected by the publications and lectures of the Institute. The scepticism of the present day was a very difficult problem to deal with; there were political sceptics of the stamp produced by the first French Revolution, who looked upon Religion as a part of the political institutions to which they objected. There were men who were sceptics from the pride of intellect, who refused to give adherence to things which did not tally with their ideas, and there were honest sceptics, who doubted that which their intellect did not understand. These last were the product of imperfect education, and with them the Society had most to do. Even if the Institute had done

nothing more than show that the inconsistency of those who refuse to believe in Christianity was greater than that of those who did believe in it, it would have done a great amount of good. We were in a transition state, and new discoveries in science were being made every day; but we might rest assured that every scientific discovery, if an absolute truth, would not be inconsistent with Divine Revelation.

The Earl of Shaftesbury, K.G.—"As President of this Institute, I have now a very agreeable duty to perform, which is to present the testimonial before you to Captain F. Petrie, who has devoted more than five years of his time to the work of this Society (during which period it has risen from 200 to 694 members), and whose patience, good humour, zeal, tact, and assiduity have done so much to bring it up to its present position. I am sure those who belong to the Society will heartily endorse what I have said, and what is here inscribed,

> "'Presented, with a Purse of 100 Sovereigns, to Captain Francis W. H. Petrie (late 11th Regiment), by the President and Council of the Victoria Institute, or Philosophical Society of Great Britain, in testimony of their high esteem, and in recognition of the very energetic and valuable services he has rendered as Honorary Secretary to the Society.'"

Captain F. Petrie having expressed his warm acknowledgments—

Professor Birks then read the Address; after which—

Mr. S. D. Waddy, Q.C., M.P., moved the 3rd resolution, that the thanks of the Institute be presented to Professor Birks for the Address, and also to all who have read papers during the session, and called attention to the great value of every Annual Address that had been delivered since the Institute's foundation, adding that they would form an admirable volume by themselves. Mr. C. Brooke, F.R.S., seconded the resolution.

The Rev. R. Thornton, D.D., moved and the Rev. Preb. Irons seconded the 4th resolution—a vote of thanks to the President, the Right Hon. the Earl of Shaftesbury, K.G., for taking the chair.

Refreshments were afterwards served in the Museum.

THE ANNUAL ADDRESS.

THE UNCERTAINTIES OF MODERN PHYSICAL SCIENCE.

My Lord Shaftesbury, Ladies and Gentlemen.

The word Science, now so much in vogue, occurs once only in our English version of the New Testament. It is where St. Paul counsels Timothy to avoid "profane and vain babblings and oppositions of science falsely so called, which some professing have erred concerning the faith."

Those Gnostic heresies and speculations, to which the warning first applied, are extinct long ago. Nothing is left of them but some fossil skeletons in the works of the Fathers. But oppositions of pretended science to the Christian faith have revived in other forms, and exist at the present day. In the name of scientific progress, faith in God, in a life to come, and in supernatural revelation, has been vigorously assailed. The chief leaders in this philosophical sect may be called Agnostics, and their creed Agnosticism. They affirm that of a Creator, a First Cause, a Supreme Governor of the universe, nothing whatever can be known. But by way of compensation they claim that their own advance in natural knowledge is "all but infinite," compared with their predecessors. From this lofty pedestal they affect to look down upon all faith in a living, personal God, and supernatural religion, as a superstition that is waxing old, and ready to vanish away.

A severe moral conflict is thus forced on all Christian believers. And in this strife, which cannot be avoided, a purely defensive attitude, a timid, apologetic tone, ill befits either the dignity of their cause or the strength of their position. There can be no conflict between the genuine sense of God's messages to mankind, and the real facts and authentic conclusions of science. But false constructions of Scripture, on the one side, and the crude hypotheses or fanciful guesswork of men of science, on the other, may and will contradict and clash, while they depart equally from the truth. It is now the

fashion with many to assume that the risk of error is wholly on the side of Christian believers. Physical science as a whole, including the newest and latest guesses of its students, has the same infallibility claimed for it, which is claimed by the Vatican Council for the Bishop of Rome. It has been made a test, not only for interpretations of the Bible, but for the Bible itself; which must be rejected and cast aside, wherever it differs from this new and later revelation, of which modern men of science are the self-appointed prophets. Religion, we are told, consists simply of blind emotions about things unknowable, while the students of nature have a rightful monopoly of knowledge, truth, and wisdom.

It is our duty to sift these proud claims, and see if they have any warrant at all in the actual state of things. This is needful in the interest of genuine science, no less than of Christian faith. An inflated paper currency must be not less unsafe and mischievous in matters of science than those of trade. Credulity is no monopoly of religious believers. It may sometimes be found even among the leaders of modern research; while among their disciples and admirers its recent growth has a tropical luxuriance, and is really almost prodigious.

Physics and physiology have no doubt made great and real progress in the last fifty years. But what, after all, is their present stage? Do they form a complete, mature, and perfect scheme of truth, a firm and lofty pedestal, from which their students may look out, unvexed themselves, like the gods of Epicurus, on the tossing waves and storms of ethical debate and religious controversy? Are they not rather in a nebulous stage, where a solid nucleus of certain or nearly certain truth is encompassed and concealed by a copious mist of unexplained phenomena, unproved guesses, and dim, hazy, floating speculations? Does not a vast cloudland or dreamland envelop this world of science, shrouding it usually with a dull, watery fog of thick vapour; but ever and anon, in some wild and monstrous hypothesis, streaming off, like the tail of a comet, into infinite space and the outer darkness? The second and not the first, I hold to be the true description of modern science, in spite of all its progress. This is true both in physics, which deal with lifeless matter, and physiology, which deals with living creatures. If true in the first, it must be doubly true in the second and higher department, which all confess to be more difficult and mysterious. My object in this address will be to establish its truth, even in physics, and for this end to consider these topics in succession; the law of gravitation, the nature of matter, the existence of ether; the

conservation of energy, with the doctrine of evolution, and the nebular theory; the dissipation of energy and the solar percussion theory; the molten nucleus theory of the earth's formation; and the astro-glacial theory of the great ice-period, supposed to have lasted for ages before man appeared on the earth.

I. The Law of Gravitation stands foremost among the doctrines of modern physics. The evidences of its truth have gone on increasing for two full centuries, ever since the *Principia* of Newton appeared. That any person of intelligence should still doubt it, after it has been confirmed by all the complex calculations and verified results of astronomy through these two hundred years, is to me a matter of wonder and amazement.

But has this truth, however firm and solid, no nebula still surrounding it? In that case, such a paper as the one in your fourth volume by your former secretary, on "Current Physical Astronomy," would have been impossible. And that paper by no means stands alone. Statements of Dr. Tyndall and Mr. Spencer, and the hypotheses named by Professor Maxwell in his articles on "Atoms" and "Attraction," prove still more decisively how much remains debated, uncertain, and obscure, even in the most certain of scientific truths.

And first, what do we mean by a physical law? Dr. Tyndall answers boldly, a fatal necessity. Torricelli, Newton, the scientific men of the present day, all knew, he says, that the succession, besides being permanent, is necessary; that the gravitating force *must* produce the observed course of the seasons. "If the force be permanent, the phenomena are necessary, whether they do or do not resemble what has gone before. Nothing has occurred to indicate that the operation of the laws has ever been suspended, or nature crossed by spontaneous action." Hence miracles are incredible. Strong in this premise, the inherent necessity of natural laws, he issues an imperial edict to all theologians—"Keep to the region of the human heart; but keep away from physical nature. Here, in all frankness, I would say, you are ill-informed, self-deluded, and likely to delude others."

So frank a statement demands a frank and simple reply. The exclusion of all theologians and believers in miracles from the fields of science rests on two grounds, a plain historical falsehood, and a patent logical sophism. If this scientific interdict is valid, Sir Isaac Newton must share in the exile denounced against all Christian divines. His authority is here quoted to prove that very doctrine which he has most clearly,

strongly, and pointedly denounced and condemned. According to him, the law of gravitation and the other laws of nature are no product of a blind and fatal necessity. "This beautiful system," he says, "of sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful being." And again—"Blind, metaphysical necessity, which is the same always and everywhere, could produce no variety of things. All that diversity of natural things which we find could arise from nothing but the counsel and will of a Being necessarily existing." Thus Newton is invoked to establish, as a test of scientific competence, that conception of natural laws, which he has plainly denounced as unscientific, unreasonable, and absurd.

But the reasoning of Dr. Tyndall is here no less defective than his inversion of historical truth is surprising and extreme. He confounds two things wholly distinct; a hypothetical necessity that certain results must follow, if such and such laws operate undisturbed; and a real necessity, that these laws must continue to operate, and can never be varied or suspended, either by some higher law unknown to us, or by the free choice of the Creator. His dictum, then, is not less opposed to common sense than to Newton's real teaching and authority. Whenever there are diverse laws among which a calculator may choose, so as to trace the consequences of one or another at his pleasure, the real existence of any one of them can be due to no blind fate, but, as Newton justly maintains, to the wise and intelligent choice of a Divine Lawgiver.

This necessity, which Dr. Tyndall affirms of all natural laws, Mr. Spencer also asserts of the law of gravitation, near the opening of his scheme of philosophy. Physicists, he says, have assumed variation by the law of the inverse square, because any other was excluded by the laws of space. He then proceeds to infer that repulsions, as well as attractions, must follow the same law, that a body in equilibrium will remain so, if the bulk be reduced to one-eighth, or the distance of all the molecules to one-half; and hence that matter can offer no resistance to compression. The conclusion, he remarks, is absurd. This absurdity, however, does not strike him as proving the utter falsity of the premise from which it is logically derived. On the contrary, he sets it down merely as one added proof that the nature of matter and of force is inconceivable.

That many other laws of force have been assumed, and their mathematical results developed, is one of the most familiar and patent facts in the history of dynamics. Five whole sections

of the first book of the *Principia* are occupied with calculations of this very kind. The premise, then, in this reasoning is a clear historical falsehood, and the conclusion, as Mr. Spencer himself admits, plainly absurd. In the third edition of his work, after fifteen years, the paragraph has been silently withdrawn. But no explanation has been given how this double inversion of fact and logic was left so long standing sentinel in the porch and gateway of the new material philosophy.

Gravitation, then, is no blind necessity, but a law of nature, proved by a combination of experience and deductive reasoning, and which thus implies and requires the choice of a Divine Lawgiver. But is it mediate or ultimate? If mediate, so as to have some other physical cause, what is the medium on which it depends? If ultimate, which is the true conception of it, universal attraction, or universal appetency? Here we find the nucleus of certain truth surrounded by a large and ample nebula of rival theories and doubtful speculations.

Newton has been careful to remark that he gives no decision on the physical cause of gravity, if such there be. "I use the words," he says, "attraction, impulse, or propensity, promiscuously and indifferently one for another. Wherefore the reader is not to imagine that by these words I anywhere take on me to define the kind or manner of any action, the causes or physical reasons thereof, or attribute forces in a true and physical sense to certain centres, when I speak of them as attracting, or endued with attractive powers."

Gravitation, if a mediate result, can hardly be attractive. For this would require us to conceive a line physically connecting every pair of masses or atoms in every varying position, and exercising a contractile power to bring them nearer. Also that the contractile force should be increased, after it has brought them nearer, and not, as in every known case of the kind, diminished. This hypothesis, then, seems never to have found a patron. But the other mediate view, that gravity is the result of propulsion, and that bodies and atoms are pushed and driven together by pressure or impact from behind or beyond, has been a very frequent view. Newton inclines to it in his 21st Query. But in Query 28 he leans, I think, just as plainly to the opposite notion, that gravity is one of two or three ultimate principles, of which cohesive force is another, which enter into the defining essence of matter, or "by which the things themselves are formed."

Of this general view, that gravitation results from ethereal impact or pressure, there have been three varieties. First, that of Le Sage, that it depends on the impact of ultramundane

corpuscles, flying in streams in all directions through space. He conceives them to come from beyond the limits of the known universe, and to produce attraction by impact on the molecules of matter, each screening its neighbour from some part or fraction of this celestial bombardment. A most grotesque machinery for securing the desired result! But there is a plain and fundamental objection. If the molecules of matter are perfectly elastic to their etherial assailants, the differential effect would cease, and the action be equal on all sides. If their motion is quenched after the impact, the energy thus transferred from the ether to the matter on which it impinges must raise the whole universe to a white heat in a few seconds.

A second theory, hinted at, rather than proposed, is of this kind. "If we suppose all space filled with a uniform, incompressible fluid, and that material bodies are always generating and emitting this fluid at a constant rate, the fluid flowing off to infinity, or else absorbing and annihilating it, the fluid flowing in from infinite space, the result would be an attractive tendency between any two bodies as the inverse square." On this suggestion of Sir W. Thomson Professor Maxwell justly observes, that such a hypothesis, of a fluid constantly flowing out with no source of supply, or flowing in without any escape, is so contrary to all experience that it cannot be called an explanation. But, with all deference to two mathematicians so eminent, I believe that the hypothesis is self-contradictory and impossible. If each particle of matter is surrounded by a plenum, nothing could flow out of it, for no room would be left into which it could flow. If by a fluid not a plenum, but homogeneous, as the hypothesis requires, it must cease to be homogeneous from the first moment when the outflow began.

A third hypothesis assumes that gravitation results from unequal pressure of the ether on the inner and outer side of each pair of masses or atoms. This is the view modestly proposed in Newton's 21st query. But his mind could not have found rest in it, since later on he inclines to a different and really opposite view. The one thing of which he seems to be sure is the exact converse of modern materialism. The main business, he says, of Natural Philosophy is to argue from phenomena, and deduce causes from effects, "till we come to the First Cause, which is certainly not mechanical."

But this attempt to explain gravity, either by vibrations of ether, or differences of ethereal pressure, in spite of the high names which have inclined to it or adopted it, seems to me

open to a decisive and fatal objection. The action of the ether is assumed to depend on variations in its density. It would press equally on all sides, and be inactive, if its density were uniform. Now in ether, which was a plenum, no differences of density could exist. Space could not be more than perfectly full. And in elastic ether, not a plenum, the chief effect of the elasticity must be to equalize the density, and reduce the differences to nothing. While this change was in progress, the result must be to increase the mutual distance of all the matter floating in the denser portions, and to bring nearer to each other those which were placed in the rarer portions only. Thus, instead of universal attraction, the necessary result would be attraction or nearer approach in one half of space, and repulsion or further separation in the other half, and by a law or rule wholly differing in both from the inverse square of the distance. And when once an equal density of the ether was attained, or nearly attained, all further action must cease. The final result could be nothing else than stagnation, silence, and death.

But if gravitation be an ultimate law, and cannot be resolved into a secondary result of impact or pressure, as I fully believe, a further doubt remains. Is attraction its true and proper name? When A and B are in presence, and B draws nearer to A, does A pull B towards it? Then the law is rightly called one of universal attraction. Or does B seek A and draw nearer to it by an inward instinct or impulse? Then the proper name of the law will be universal appetency. This last, though not the usual, I hold to be the more natural and reasonable view. It places the activity where the change occurs, not in every other place beside. It also brings the law into harmony with the higher forms of desire and appetite in all living creatures. Instead of a type of selfishness, an action that aims to contract and absorb all things into itself, it becomes a type and resemblance, in matter, of that higher law of human and divine love, which goes forth in desire for closer union and communion with the whole universe of being.

But "whether thus these things, or whether not," whether gravitation be mediate or immediate, attraction or appetency, I think it must be plain that the nucleus of solid truth, even in Newton's great discovery, is encompassed to this hour with a vast nebula of what is doubtful, indeterminate, and obscure.

II. The Nature of Matter is the next subject to be considered. Are modern materialists fully agreed in the nature of

this new divinity, which is their only substitute for the God of the Bible? Dr. Tyndall discerns in it "the promise and the potency of all terrestrial life." Professor Huxley prophesies "As surely as every future grows out of past and present, so will the physiology of the future extend the reign of matter and law, until it is coextensive with knowledge, with feeling, and with action." "The consciousness of this great truth weighs," he thinks, "like a nightmare on many of the best minds of the day, and they watch the progress of materialism with such fear and powerless anger, as a savage feels when the great shadow creeps across the sun." And Professor Haeckel, of Jena, extols Kant's Nebular theory, because "it is purely mechanical or monistic, makes use exclusively of the forces of eternal matter, and entirely excludes every supernatural process."

A philosophy, then, in which matter supersedes and swallows up mind, and dispenses wholly with a God, ought surely to give some distinct utterance as to the nature of its own divinity. But when we look closely, what do we find? Nothing but obscurity and contradiction, clouds and thick darkness.

And first, this Matter which has "the promise and potency of all terrestrial life," does it really exist at all? The leaders of the new philosophy are not agreed, even as to its bare existence. The doctrine of Berkeley, which denies an objective material world, and reduces everything to mental ideas and sensations, has had many disciples down to our own day. Mr. Mill speaks with scorn of those who profess to see in this theory any contradiction of reason and common sense. He adopts it fully, and would baptize all material objects by a new name. They are things no longer, but only "permanent possibilities of sensation." But how can feelings and sensations be possible, if there is no thing to be felt, and no person to feel? The whole universe of thought becomes a multiplied heap of sentences, in which the copula only is left, and both the subject and the object are stolen away.

Such is the first variety in that sensational creed, which is to replace Christian faith, and belief in the Bible. Mind perhaps may exist, and at least a compromise is proposed. "The wisest thing is to accept the inexplicable fact (of memory) without any theory of how it takes place; and when we speak of it in terms which assume a theory, to use them with a reservation as to their meaning. No such difficulties attend the theory in its application to matter." That is, in plainer words, we may speak of minds as existent, reserving a secret doubt

whether they exist or not. But in the case of matter the reserve is needless, and we may safely adopt the theory of its non-existence, as any thing apart from a percipient mind.

It is the striking remark of Gibbon on the history of Bajazet —"The savage would have devoured his prey, if in the fatal moment he had not been devoured by another savage stronger than himself." And here we have a sign that, while Materialism is prophesying its victories, and seeking to engulf both morality and religion within its ravenous jaws, Nihilism, another form of error, is lying in wait for it to destroy it in its turn, and replace it by a negative creed of nothingness and utter darkness.

Let us turn to Mr. Spencer, and see there another form of the materializing theory. His doctrine may be summed up in two or three principles. First, matter is indestructible, and this indestructibility is an *a priori* truth, since no demonstration of it *a posteriori* is possible. Secondly, matter, as an absolute reality, is some mode of the unknowable, related to the matter we know as cause to effect. Thirdly, phenomenal matter, the relative reality we know, is made up of the phenomena or sensations we experience from material objects.

We are thus involved, a second time, in a hopeless contradiction. Phenomenal matter is constantly destroyed. The candle burns away and disappears. The gunpowder explodes and vanishes, and the sensations it gave to our touch and sight come to an end. The cloud melts away into the blue sky, and is no more. But non-phenomenal matter, the absolute reality, by the theory is one form of the unknowable. Of this we cannot know, then, whether it can or cannot be destroyed. And still the indestructibility of matter is to be reckoned a fundamental *a priori* truth. What contradiction can be more complete? How can we found an all-conquering, all-inclusive philosophy on the basis of a palpable contradiction?

But this is only the first step in the internal antagonisms of this material philosophy. First, physicists are not agreed whether matter is to reign alone, or whether there is an ether also, to share its dominion. M. Comte, Justice Grove, and some others, hold the first alternative, but nine-tenths of scientific students adopt the other view. In this, I believe, they are fully justified by the facts of science. But then we have, in this one fact, a barrier which the tide-wave of materialism can never surmount, and though its waves may toss themselves, they can never prevail against it. It is hard and impossible to conceive of millions or trillions of atoms creating themselves. But it is harder and still more impossible to

conceive that each of them chooses in the moment of its birth, whether it shall become an atom of matter or one of ether.

Let us briefly compare our knowledge and ignorance on this question of the nature of matter, so fundamental in the philosophy of materialism. We know, first, in spite of Mr. Mill's dissent, that matter does exist, is an objective reality, and no mere possibility of mental sensations. We know, next, in contrast to Mr. Spencer, that some knowledge of its properties is attainable, and that it does not belong to an Absolute Something wholly unknowable. We have strong reason to believe that it is composed of ultimate atoms, whether finite in size, or force-centres and points, whether of various shapes or spheres only. My conviction is that we may know further that the vortex atoms of Helmholtz are impossible figments, and that the hypothesis, instead of being self-consistent, involves more than one direct and essential contradiction. But what do we know beside concerning its nature? Almost nothing. We do not know certainly whether these atoms are finite in size, or force-centres, whether various in shape, if finite, or spheres; whether the chemical elements have atoms essentially distinct, or convertible into each other; whether or not these atoms have any powers at all, except change of place, attraction and repulsion, or appetency and aversion. In their laws, as detected by science, there is nothing at all which can explain either their number, why they are not fewer or more numerous; or their position, why they are at such and such distances and in such directions, and not in others; or their distinctive laws of mutual action, in approaching to or receding from each other. For all these there is and can be no key or reasonable explanation, but in the decree and will of an all-wise Creator, the Supreme Lord and Architect of the material universe.

III. The Existence and Nature of Ether is a third subject, on which there rests a still greater obscurity. If it really exists, the knowledge of matter and of ether must plainly be the two pillars on which the science of physics must rest. But doubts are greater, and the conflicts of opinion still more various than before.

And first, does this ether exist? Such is the general opinion of physical students; and for myself, I have no doubt of its truth. But the dissentients are not few. M. Comte denounces the theory as an equal illusion with the vortices of Descartes. Mr. Lewes, his disciple, shares the same view. Mr. Mill, in his *Logic*, inclines to the same side. The hypothesis, he says, is not without an analogy to that of Descartes,

only that "it is not entirely cut off from the possibility of direct evidence in its favour." He has the strange idea that there can be some evidence of an hypothesis, besides that of accounting for the phenomena it has to explain. Mr. Justice Grove, in his "Correlation and Continuity," holds strongly to the negative view. But the idea that the immensely diluted and attenuated matter of the planetary spaces can have the intense elasticity implied by the speed of light seems to me wholly incredible.

Next, if ether exists, is it of one kind only, or more than one? By way of compensation to the last opinion, some theorists affirm that there are two kinds of ether, one called electric, the other luminous. Others go further. The authors of the *Unseen Universe* seem disposed to suggest a series of ethers, more and more subtile, of which the second may have nearly the same relation to the first which the first bears to common matter. This is very like a reproduction of the *æons* and genealogies of the early Gnostics in a physical and material form.

Again, is the ether continuous, or discontinuous and atomic? Professor Challis holds strongly the former, but Newton, Young, Fresnel, Airy, Cauchy, Stokes, and most other physical philosophers, the latter view.

Is this ether attractive or self-repulsive? The latter, the usual opinion, seems to me essential to a just conception of its nature. But Professor Bayma, in his *Molecular Physics*, maintains that it must be attractive. And Sir George Airy, in private, once told me that, in his opinion, the phenomena of light required the notion of attractive or contractile forces, and stretched strings, rather than repulsive force-centres, though this must imply some kind of fastening or attachment to walls of the universe.

Again, what is the relation between ether and common matter? Newton suggests that ether is denser outside of solids, and less dense within them. This would imply that they exert on each other a repulsive power. But Mosotti, Norton, and most other modern theorists, make the mutual action attractive, so that it would be denser within bodies, and at their surface, than in free space.

Once more, if the ether is self-repulsive, and intensely elastic, how is this elasticity maintained? Must it not diffuse itself into empty space? Or are we to conceive the universe bounded by a solid wall, able to resist an almost infinite pressure? Sir John Herschel has remarked: "Under no conception but that of a solid can an elastic and expansible medium

be self-contained. If free to expand, it would require a bounding envelope of sufficient strength to resist its outward pressure. To evade this by supposing it infinite in extent, is to meet the difficulty by words without ideas, and to take refuge in a negation of that which constitutes the difficulty."

Thus, from Newton to the present day, all these various doctrines about ether have been held by men of eminence; that there is no such ether distinct from matter, that there are two kinds, or many, each rarer than the one before it, or one kind alone; that it is a solid and a fluid, attractive and repulsive, a continuous plenum, or made up of discontinuous atoms; that these are solid and finite, or points and force-centres only; that it is attracted by matter, that it is repelled by it, and that it is neither attracted nor repelled, but merely is shut out from the space this occupies; that it is finite in extent, and that is infinite, a repulsive variety of material substance, or a bridge between the visible worlds and an unseen universe.

Physical science, with regard to the nature of matter and ether, its two constituent elements, is thus in its merest childhood. It has yet to decide which is true out of a dozen or a score of rival theories. Its teachers, then, and still more its disciples, will do wisely to assume a far more modest tone in dealing with moral and religious questions than has been their practice of late years. It is ridiculous for those to declaim on the diversity of religious creeds, and the controversies and strifes of theologians, who can hardly agree in laying a single stone in the foundations of their own philosophical system.

IV. The Conservation of Energy, the Doctrine of Evolution, and the Nebular Theory, are so closely related that it will be better to examine them together. The great divergence among scientific theorists, and the large amount of what is doubtful or untrue in their reasonings will thus be seen in a clearer light. Has there been really that almost infinite progress, of which Dr. Tyndall speaks, beyond Newton and Leibnitz and the students of last century? Have the present generation of physical students, by virtue of these doctrines, a far deeper insight into the true system of nature than their predecessors could ever attain? This, I believe, is a grand illusion, fraught with no small degree of moral mischief. Analysts have made some real advance in dealing with various dynamical problems. Observation and experiment have unfolded more clearly the connection between diverse forms of physical change, usually expressed by different names. But along with this advance

there is great danger, what with the coinage of new phrases for old ideas, and free scientific guess-work, of going backward instead of forward. Already, in more cases than one, mere verbiage, or even direct contradictions, have been palmed on the credulous as grand experimental discoveries, or still more grand *a priori* truths.

What, then, is this Energy, about which such great discoveries have been made? Few of those who speak or write about it seem to have settled clearly what they mean by the term. Is it force or motion? Is it both or is it neither, being something quite distinct from both? All these four opinions seem to be held, and by writers of some eminence. According to Mr. Spencer, it is force, and the better name for the conservation of energy is the persistence of force. According to Mr. Grove it is motion, and the various forms of energy are "modes of motion." According to Professors Thomson and Tait, who understand the subject better, it is both, or rather each in turn. It has two kinds, potential and kinetic. The first is an integral of forces, such as have acted or will act, when a system passes from a first to a second position. Kinetic energy is an integral of velocities or motions, or their total amounts from zero up to their actual values at any given time. These are three varieties, that it is force, motion, or partly one, partly the other. Mr. Brooke adds a fourth variety, that it is neither force nor motion, but a third something, distinct from both. While he distinguishes it from force, he also inverts the use of the two terms. His Energy is exactly the same as the Force of Newton's definition, and of nearly every work on dynamics; while his Force is the Potential Energy of Sir W. Thomson's analytical theory.

According to Mr. Spencer, the Conservation of Energy, or as he prefers to call it, the Persistence of Force, is the chief and foremost of all *a priori* truths. It holds in his philosophy exactly the same place as the Being of God in the Christian system. It transcends both demonstration and experience, and is the widest and deepest of all truths. But no sooner has this doctrine, borrowed from the analysts, been adopted by Agnostic metaphysicians, and raised to an intellectual throne, as a substitute for the living, personal God of the Bible, than it is confronted by a rival, a younger son of the same parents, the Dissipation of Energy. It is the same analysts, from whom the first doctrine has been borrowed, who are the sponsors of this rival and successor. Like the giant in the Hindoo tale, the new divinity

of fatalism places its hand on its own head, and in a moment is reduced to ashes. I will give three statements of this second doctrine from Professor B. Stewart's *Conservation of Energy*, Thomson & Tait's *Natural Philosophy*, and the recent work, *The Unseen Universe*. The first writes as follows:—

"Although in a strictly mechanical sense there is a conservation of energy, as regards use or fitness for living things, the energy of the universe is in process of deterioration. Diffused heat forms what we may call the great waste-heap of the universe, and this is growing larger every day. We have regarded the universe, not as a collection of matter, but an energetic agent, a lamp. Looked at in this light, it is a system that had a beginning, and must have an end; for a process of degradation cannot be eternal. If we regard it as a candle that has been lit, we become absolutely certain that it cannot have been burning from eternity, and that a time will come when it will cease to burn."

Sir W. Thomson writes thus in his joint treatise, with Professor Tait, on *Natural Philosophy*. "It is quite certain that the solar system cannot have gone on, as at present, for a few hundred thousand or a million years, without the irrevocable loss, by dissipation, not annihilation, of a considerable portion of the entire energy, initially in store for sun heat and Plutonic action. It is quite certain that the whole store of energy in the solar system has been greater in all past time than at present. It is probable that the secular rate of dissipation has been in some direct proportion to the total amount of energy at any time after the commencement of the present order of things, and has thus been diminishing from age to age . . . . Hypotheses assuming equability of sun and storm for a million years cannot be wholly true . . . . I think we may say, with much probability that the consolidation of the earth's crust cannot have taken place less than twenty, nor more than 400 million years ago. I conclude that Leibnitz's epoch of the 'consistentior status' was probably between these dates," (*N. P.* pp. 712-716).

We read also in *The Unseen Universe* as follows, p. 91:— "Heat is the communist of our universe, and will no doubt bring the system to an end. The sun is the furnace, or source of high-temperature heat to our system, as the stars to other systems. The energy essential to our existence is derived from the heat the sun radiates, and represents a very small part of it. But while the sun supplies us with energy, he

himself is getting colder, and must ultimately, by radiation into space, part with the life-sustaining power he now possesses. In each case of collision, there will be the conversion of visible energy into heat and a partial and temporary restoration of the power of the sun. At length, however, the process will have come to an end, and he will be extinguished; until, after long ages, his black mass is brought into contact with that of his nearest neighbour."

The idea is then pursued further, as follows:—

"After unimaginable ages these two stars, the Sun and Sirius, having each long since devoured his attendants, and exhausted their heat energy by radiation into space, may be imagined travelling towards each other with accelerated motion. They will at last approach each other with great velocity, and finally form one system. The two will rush together and form one mass, the orbital energy being converted into heat, and the matter probably evaporated and changed into a gaseous, nebulous condition. Ages pass away, and the large double mass ultimately shares the same fate that long since overtook the single masses that compose it. It gives out its light and heat into space, and becomes dark, until it comes to form one of the constituents of a still more stupendous collision. By a process of this kind the primordial potential energy is gradually converted into light and heat, and then ultimately dissipated into space."

Such is the doctrine of the Dissipation of Energy, as held by the three eminent physicists and mathematicians, Professors Sir W. Thomson, Tait, and Balfour Stewart. Mr. Spencer, again, has seven chapters on the kindred subject of Evolution, and defines it in these words:—"A change from incoherent homogeneity to coherent heterogeneity, accompanying the dissipation of motion, and the integration of matter." This is plainly, in abstract terms, the same process just described, by which suns, with their planets, are formed out of nebula, then the planets fall into the suns, and the suns in long succession into each other. A strange inversion of the natural meaning of the word, evolution, when it is made to denote the tendency of an expanded nebula to roll itself up into one mighty central mass!

Let us now take Professor Haeckel's account of the nebular, or as he calls it, Kant's cosmological gas theory. It reads as follows:—

"Kant's cosmogeny maintains that the whole universe, inconceivable ages ago, consisted of a gaseous chaos. All the

substances found at present deposited on the earth, and other bodies, originally constituted one single homogeneous mass, equally filling up the space of the universe, which, in consequence of an extremely high degree of temperature, was in an exceedingly thin gaseous or nebulous state. The millions of bodies which at present form the different solar systems did not then exist. They originated in consequence of a universal rotation, during which a number of masses acquired a greater density than the remaining mass, and these acted as central points of attraction. There arose a separation of the primary nebula into a number of rotating nebulous spheres. While the centripetal force attracted the rotating particles nearer and nearer to the central point of the nucleus, the centrifugal force always tended to separate the peripheral particles farther from it. . . . . As these simple processes repeated themselves over and over again, there arose the different solar systems, the planets revolving round their suns, and the satellites, or moons, round the planets."

Such is the outline given of Kant's, more usually called Laplace's, theory. The merit is claimed for it that it is "purely monistic, and entirely excludes every supernatural process, and pre-arranged and conscious action of a personal Creator." But its high excellence as an atheistic theory is not without its shadow. Some weak points, Professor Haeckel observes, still remain, which prevent our placing in it unconditional confidence, and these are stated as follows:—

"The theory furnishes no starting-point at all in explanation of the impulse which caused the first rotary motion in the gas-filled universe. In seeking for such an impulse, we are involuntarily led to think of a first beginning. But we can as little imagine a first beginning of the motion of the universe as of its final end. The universe is unlimited and immeasurable, both in space and time. It is eternal, and it is infinite. Nor can we imagine a beginning or an end to the eternal motion, in which all the particles of matter are always engaged. The great laws of the conservation of force and of matter admit of no other supposition. The universe is a connected chain of phenomena of motion, necessitating a continual change of form. Every form as a temporary result is perishable, and of limited duration; but in this change matter and the motion inseparable from it remain eternal and indestructible."

The Nebular Theory, then, as understood by Professor Haeckel, implies that matter is infinite both in quantity and

in its past duration; that it has been in motion from all eternity, and can never rest; that the universe has no beginning and no end; that this view is required by those grand discoveries of modern physics, the conservation of matter and of force; that the nebula, vast ages ago, was intensely hot, and has since gradually grown cooler, while severing into distinct masses, and acquiring a rotatory motion.

All these principles are exactly reversed by the authors of the *Unseen Universe*, who are first-class mathematicians. They hold, as the result of the dissipation of energy, that the universe had a beginning, and must have an end; that it is like a candle which has some time been lighted, and cannot burn on for ever; that this doctrine, instead of being opposed to the conservation of force and matter, is the natural sequel and complement of those theories; and finally, that all the heat of the sun and stars, instead of being due to the high temperature of the nebula, is wholly the creation and result of its latter condensation. So (p. 125) we read that "as the particles condensed or came together, the potential energy was gradually transmuted into the energy of heat and of visible motion."

In Mr. Spencer we meet with a third form of the Nebular Theory, and Physical Evolution. The theism of the authors of the *Unseen Universe*, who affirm a beginning and an end, and the monism or atheism of Professor Haeckel, which wholly denies both, is pronounced alike unphilosophical. That question belongs to the class of which nothing can be known. For the rest, he holds the indestructibility of force, and the continuity or eternity of motion, as a great *a priori* truth. But he holds, side by side with it, the Dissipation of Energy, or a process "which must go on bringing things ever nearer to complete rest." If equilibration, he asks, must end in complete rest, what is the fate towards which all things tend? "If the sun is losing its force at a rate which must tell in millions of years, and men and society are dependent on a supply that is gradually coming to an end, are we not manifestly progressing towards omnipresent death? That such a state must be the outcome of the processes everywhere going on seems beyond a doubt." But a further suggestion is made, that, when the last collision of suns and systems occurs, there must ensue a diffusion that undoes the previous concentration. So that a period, inconceivably vast, of evolution, that is, condensation, may be followed by a paroxysm of dissolution, that is, of re-expansion into nebula once more.

Thus the mighty pendulum of the universe may swing on backwards and forwards for ever.

Now on these three forms of the nebular theory, linked closely with the doctrine of evolution, and the conservation of energy, two questions must arise. Do these witnesses agree? Are they not in plain contradiction to each other? And next, are they, where they agree, certain truths of science, or imperfect and perhaps erroneous conjectures, on subjects where all the data are not at present certainly known? Has this doctrine of an incessant, purposeless oscillation from nebulous mist to suns and starry systems, and from these back to mist again, dark, dreary, and hopeless, on its moral side, any claim whatever to be reckoned a true and just exposition of the known laws of physical change? I believe firmly the exact reverse. I hold it to be as baseless in physics as it is full of darkness and gloom to all the deeper wants and aspirations of the human heart. It degrades that inscrutable Power which it refuses to name, and of which it affirms that we can know nothing, into a drivelling idiot, engaged for ever "in dropping buckets into empty wells, and growing old in drawing nothing up"; who goes on, like a convict under his sentence, turning for ever and ever, to no profit, the vast tread-wheel of the universe.

I pass by the question of beginning or no beginning, in which the author of *The Natural History of Creation* contradicts flatly, not only the very first word of Divine Revelation, but the clear voice of sound reason. Be it so, that matter is unlimited in quantity, and in past duration. What result must follow? The doctrines of the conservation of force and matter, instead of being confirmed, will be turned into unmeaning sounds. For the essence of these laws is that the amount of matter or force is always the same. But there can be no measurement of that which is infinite and unmeasurable. If the laws are true, the quantity of matter must be finite, and the quantity of energy must be finite and measurable also.

Again, if motion is essential to matter, and it has always been moving, the logical ground of the nebular theory is destroyed. Motion is the effect of force. In the present state of things forces and motions co-exist. A simpler state, then, would be one in which there are forces tending to produce motion, but no actual movement. If all motion is due to a past exercise of force, we must go back in thought to a time when there were no motions, but forces only. This is the true ground of reason for a nebular theory. Such a

state must certainly have been one of wide diffusion of matter, as well as of perfect rest. But if matter has been in motion from all eternity, no one stage of this incessant change can be more simple than another. There would, then, be no reason for accepting a primitive nebula, unless we could prove by strict reasoning that such was actually the state of things long ago. That attractive forces, beginning from a state of rest, would lead to rotatory motion, such as those we observe in the heavens, is the only real basis of any nebular theory.

Next, the assumption that the first state of the nebula was one of intense heat is flatly opposed to the real principles of modern science. It belongs to the exploded hypothesis that caloric is a distinct substance, and not merely atomic motion. The universe, in a state of extreme diffusion, would resemble the highest and rarest parts of our atmosphere, and only be much rarer still. The feature of those regions is not intense heat but extreme cold. The true conception of the primitive nebula is that of a system at perfect rest, but with forces that can generate motion. Now heat is really atomic motion, and hence the primitive temperature must have been an absolute zero of cold. Such, accordingly, is the doctrine laid down in the *Unseen Universe*, that heat results from potential energy transformed in the process of condensation.

Every single point in this atheistic nebular theory involves a direct logical contradiction. First, if the universe be full of matter, there could be no motion, for no mass or particle could find any unoccupied place into which to move. There could be no attractive force, for how could parts draw nearer to each other, when every spot between was perfectly full? There could be no rotation in a homogeneous mass, since there will be just as much reason for turning one way as another. There could have been no primitive heat, since heat is motion, and there could be no change of place in a plenum, when no particle has any place not already filled, into which it could remove. There could be no condensation for the same reason.

The nebular theory, in its only reasonable form, requires these postulates; a system of material atoms, finite, however vast, and therefore capable alike of motion and of increase; a beginning, that is, a primitive state of perfect rest, in which there are forces, but no motion, and therefore not a high temperature, but a perfect zero of cold; a finite past duration, since if we went further back, the later motions must reappear, only with their directions reversed, and the whole ground of the theory would be swept away. And above all, we need a Creative Will, to determine the number and the place of all

the atoms, and the laws of attraction and repulsion that must guide and determine all their later movements. For the grand aphorism of Newton must remain for ever firm and sure, however sciolists strive against it. "Blind necessity, which is always the same everywhere, could never produce this beautiful variety of things."

It is folly to derive a state of motion from one of rest, if motion has been eternal, or to describe an original state, if there never was an origin. The nebular theory, in the hands of the atheist, shares the fate of the corpse of Priam—

> Jacet ingens litore truncus,
> Avulsumque humeris caput, et sine nomine corpus.

Evolution, again, in Mr. Spencer's work, is only an obscure synonym for the process of cooling. A heated body contracts and condenses when it cools, and this, in more learned phrase, is the integration of matter. It parts with some of its heat to the cooler bodies around it, and this is the dissipation of motion. Incoherent gases, by cooling, become imperfectly coherent fluids; and these, when cooled further, coherent solids. A sea of aqueous vapour, or a bowl of water, to sense, is wholly homogeneous; but ice-crystals are more or less sensibly heterogeneous. Thus mere cooling combines all the characters of evolution in Mr. Spencer's definition.

But can this be really the grand secret of nature, the key to a new and improved system of physical science? Is this the discovery which is to throw that of Newton into the shade, and absorb into itself all mental philosophy and Christian faith? A primitive nebula, intensely heated at first, has gone on cooling for almost infinite ages! If true, this would be grotesquely inadequate as a theory of all physical change. For this demands, not loose phrases or metaphysical verbiage, but distinct laws of force, like the law of gravitation; and of these the theory offers no trace. But it is not true. It is rather the direct opposite of the truth. The primitive nebula, on the only hypothesis which gives us a right to assume its existence at all, cannot have been intensely hot, but at an absolute zero of cold. Heat is atomic motion. And all motion, in a true nebular theory, can only result from attractive forces in a nebula at rest, and its later condensation. The cooling, which Mr. Spencer mistakes for the whole process, and calls evolution, is only a secondary result of the condensation, or the heating process which directly results from attractive forces, and which must have gone before. Evolution is not simple

cooling. Heating by attraction and pressure, and later cooling of the central parts of each mass by transfer of motion towards the surface, are successive stages in the progressive development of cosmical change.

V. Modern theories of Solar Heat, and the Dissipation of Energy, are the next doctrines that I shall briefly examine. Two main views on the former have been lately proposed. The first is that of Mayer, accepted for a time by Sir W. Thomson, but since abandoned. It assumes that the sun is hammered into a white heat by the continued impact of falling meteors. But this view belongs now to a past lunation of science. The present favourite is the doctrine developed by Helmholtz, adopted by Sir W. Thomson, and embodied by Mr. Spencer among the latest improvements of his own system. He writes of it in these words:—

"Professor Helmholtz estimates that since the time when the matter of the solar system extended to the orbit of Neptune, there has been evolved 454 times the amount of heat which the sun has yet in store. He makes an approximate estimate of the rate at which the remainder is being diffused, showing that a diminution of his diameter by one ten-thousandth would produce heat at the present rate for two thousand years; and that thus, at the present rate, his diameter would diminish one-twentieth in the next million years..... No uncertainty in the data, and consequent error in the inferred rate at which the sun expends his reserve of force, militates against the proposition that this reserve of force *is* being expended, and must in time be exhausted."

This same doctrine, of the ceaseless dissipation of the solar energy, and indeed of that of the whole universe, is also expounded by Professor Stewart in these words:—

"While you with the greatest ease transform work into heat, you can by no method in your power transform all the heat back into work. The process is not a recoverable one. The consequence is that the mechanical energy of the universe is every day more and more changed into heat. Now, if this process goes on, and always in one direction, there can be no doubt about the issue. The mechanical energy of the universe will be more and more transformed into universally-diffused heat, until the universe will no longer be a fit abode for living things. The conclusion is a startling one. We are led to look to a beginning, in which the particles of matter were in a diffuse, chaotic state, but endowed with the power of gravitation; and to an end, in which the whole universe will be one equally-heated, inert mass, from which everything like life, motion, and beauty will have utterly gone away."

Here two questions arise. Is this new doctrine of the ceaseless dissipation of energy true and sound? Is either theory of solar heat, which has been connected with it, a settled fact of science, or a guess in the dark, against which there are strong and decisive reasons? In spite of the great names which have espoused this theory, I believe that its baselessness admits of strict demonstration. Its true place is not even among the uncertainties, but the mistakes and errors of science.

And, first, how can the conservation of energy and its ceaseless dissipation agree together? If the total amount is always the same, it cannot undergo a process of constant diminution. The reply is, that it is not annihilated, but goes off into infinite space. This is plainly impossible in any other sense than that the universe expands without limit. There can be no energy anywhere, without matter or ether to which it belongs. Abstract qualities cannot exist alone. There can be no kinetic energy or motion without something that moves. There can be no potential energy, a function of distances, without particles or masses to which these distances appertain. The only reasonable sense of the phrase, dissipation of energy, is that the system occupies a wider space than before. But perhaps the outmost parts, in receding, cease to have any practical connection with all the rest. This is just as impossible as an absolute loss. The law of gravitation alone forbids it, and links every part of matter indissolubly with all the rest.

Again, the radiant heat and light, which cause the dissipation, are only one part of the total result of a previous condensation. This is the very essence of the nebular theory. That this heat and light should cause a dissipation or expansion of the system far beyond the original bulk or space of the primitive nebula is really the doctrine that part of a thing may be greater than the whole.

Next, what can become of the lost energy? Professor Stewart makes answer: "We can only reply that, as far as we can judge from our present knowledge, the radiant energy not absorbed must be traversing space at the rate of 188,000 miles a second."

Now what does this answer imply? The ether is conceived to extend far beyond the system of which it is an essential part, and that with unabated elasticity. If there is no restraint at the boundary, it must have gone on expanding, from the date of the first nebula, through countless ages. However great the original elasticity, it must have become insensible in amount millions of years ago. The first word in a true record

of man's creation, in this view, would not and could not be—Let there be light! but rather, Let there be eternal stagnation and midnight darkness.

To account for the high elasticity of the ether, after ages have passed, we must either assume a solid limit or boundary of the stellar universe, such as Milton describes, or else that the ether thins and is less elastic at the outside, like the highest strata of the earth's atmosphere, till its repulsion is balanced by its affinity for the matter which adjoins it. In either case there could be no dissipation of energy. It would be restored either by rebound from the solid wall of the system, or, on the other view, by change into potential energy at the elastic boundary of the universe.

But the energy, though its amount be unchanged, may perhaps become degraded and inferior in kind. Working energy may grow idle and worthless. As unequal temperature, it can do much work. As equalized temperature, its working power is gone. The great waste-heap goes on accumulating, as posterity may learn some day to their cost. The universe will then become "an equally-heated, inert mass, from which all life, motion, and beauty have utterly gone away."

Heat is atomic motion. Equal diffusion of heat cannot, then, be the same with absolute rest. If the heat of our solar system were shared equally among the sun, planets, and satellites, we should not be frozen to death with absolute cold. On the contrary, we should plainly be burned up with a fiery conflagration. The temperature of our globe would become much higher than the heat of melted iron.

In the view of science energy is only of two kinds. The nebular theory implies that it was once mainly potential, or the energy of distance, and that motion, the other kind of energy, has replaced the first, as the nebula condensed. The effect is surely not more noble than the cause, the child than its parent. If one part of the motion engendered, that is, the heat, is retransformed into the other kind, the change can be no degradation. The working power cannot be lost. It is rather restored, and only passes beyond our human control. It provides for a renewal of work in some other form. Even in our farms, manure and sewage are utilized, and turned into sources of increased fertility. Man's range of power is limited, and *our* great sewage problem is still unsolved. But the powers of nature have a far wider range. In spite of desponding theories, we may be perfectly sure that there is no real waste-heap in God's glorious universe.

The main fault of the doctrine lies here. Matter and ether

need three laws to determine their mutual action. The action of matter on matter is known, the law of gravitation. Out of this law, applied to a vast, diffused, finite system of matter, the nebular theory has grown. It accounts, by the working of that law on such a nebula, for many leading phenomena of our solar system. The action, again, of ether on ether, though its law is not known, must be self-repulsive, in order to explain its nearly equal diffusion. If it condensed into patches, the transmission of light would cease. Out of this law grows the doctrine of dissipation. Heat, or atomic motion, if impressed on the ether, must be transmitted in all directions with the speed of light. The limit to which this action tends is complete equality. Hot bodies must grow cool, and cool bodies be heated, till the balance is restored. But in this reasoning the third law, also unknown, but certainly attractive, the mutual action of matter and ether, is left out of sight and forgotten. Yet it is one most essential element in the problem. Without some law of this kind, the atomic heat could not affect the ambient ether at all, and there could be no radiation.

The doctrine that the total amount of heat never changes, and that its transmission is in proportion to difference of temperature, cannot be absolutely true. It is only a relic of the now exploded theory, that caloric is a distinct and peculiar substance.

When light and heat travel from an incandescent body through space, the most palpable result is to heat the solid bodies within its range. So far there is a simple transfer of heat, and nearly in the ratio of the excess of temperature. But is this the sole effect? Does no part exercise a repellent power, and become reconverted into increased distance or dilatation? The answer should have been plain to the eye of science from the first. Within a few months it has received a striking experimental confirmation. What means the rotation of the blackened discs in that new-invented instrument, the radiometer? Clearly, that one effect of radiant heat and light is direct repulsion, by which the bodies on which it falls must be driven a little further from the source of that radiation.

This is not the whole truth. Clouds, it is known, tend to disappear under the light of the full moon. So it is clear that some part of the energy in the sun's light and heat will be spent in rarefying any nebulous patches, thicker than the rest, in the thin and rare matter of the planetary spaces through which it travels.

Again, by the laws of mechanics, some part, and perhaps the main part, must be spent in creating ethereal currents.

Disturbed ether must have a greater mutual repulsion than ether undisturbed. The motion, in mechanical effect, will be equivalent to an increased density. That the repulsive action may be equal everywhere, the ether must be thinned where the disturbance is greatest, and become denser in all other parts of the system.

These three changes limit and modify the doctrine of the equal diffusion of heat, and should have been clear to students of physics, as soon as the Baconian view of heat was reestablished. I have held them myself for forty years, and expressed them at the close of my work on Matter and Ether, published fourteen years ago. One of them has now, within a few months, been made beautifully patent to the senses of all men. They disprove that doctrine of the ceaseless dissipation of energy, which we find in so many recent works of science, and replace it by a doctrine essentially different, its ceaseless circulation.

The view of Mayer, that solar heat is kept up mainly by the dropping in of meteors, is now abandoned by its late adherents. It has died an early death. The suggested cause is too irregular, fitful, and uncertain, to account for the grand fact of ceaseless solar radiation. And there is this further objection, that the consequent increase of the central mass must have shortened the year by one or two hours in the course of the last four thousand years.

The theory of Helmholtz is now in vogue, which would supply the constant waste in radiation from the further contraction of the solar mass, and not its increase. But this, I believe, admits of almost as plain a disproof as the other. For what result must follow? The heat and light would then be greatest when the contraction is most rapid, that is, in the earliest stages of condensation. But all the known facts and known analogies point the opposite way. The more nebulous a star, the smaller and dimmer its light. The most luminous, like Sirius, are those which appear to have most distinctly a fully-condensed central body, like our sun. If the radiant energy were lost in the depths of space as soon as generated, how could the light and heat of the sun have ever reached their present amount?

The true key to the problem will be found, I believe, in a strict application of dynamical reasoning to a vast dual system of matter and ether. It is confirmed by the double analogy of air and ocean currents on the surface of our globe. Radiant light and heat cannot be lost. If part travels out to other systems, the celestial exchanges cannot be all on one side. Our

imports must surely balance, or nearly balance our exports. A small part only is arrested by the planets and satellites, and supplies their light and heat. A smaller portion may be spent in repelling them from the sun, so as to counteract the effect of resistance, or in dilating nebulous matter in the equatorial zone of our system. But the main part, travelling out as ethereal motion, will transform itself at every step of the vast journey into ethereal condensation. There must plainly be an excess of motion in the parts of our system bordering on the ecliptic and the sun's equatorial plane. There the ether must be thinned. As the heated water of the tropics flows north and south on the surface, and returns condensed and cooled in an undercurrent to the tropics again, so in this vaster and wider system. Towards the outmost planets, and even beyond them, the ether must move in a steady, invisible current to the polar regions of the great celestial sphere, which are not disturbed by the immense rotatory action of the central mass. It will return to the sun, not as light and heat, but as ethereal compression, in the latent energy arising from an excess of density, and will then by the rotation be transformed into sensible light and heat once more. Such a circuit results demonstrably from the laws of physics, even so far as they are actually known. It answers to the double analogy in the currents of the air and the ocean. Instead of a waste-heap growing larger and larger, till all life, motion, and beauty are buried under the vast accumulation of a motion that will not move, and energy that lies idle and powerless, it reveals a grand scheme of circulation, akin to the systole and diastole of the human heart. The sun might thus without a miracle dispense light and heat, undiminished, and perhaps even increased by further condensation, for millions of years or ages still to come.

VI. Again, the doctrine that the earth consisted of a thin crust, formed by cooling on the surface of a sphere liquid with heat, was long accepted as an axiom of physics, and was current in all scientific manuals. A rude shock was first given to it by some papers of Mr. Hopkins, in which he showed that the phenomena of nutation required this solid crust to have at least the thickness of many hundred miles. And now its reversal and rejection have become more complete. The earth's rigidity has been submitted to mathematical analysis by Sir W. Thomson. And he writes that this investigation "suffices to disprove the hypothesis, hitherto so prevalent, that we live on a mere shell of solid substance, enclosing a fluid mass of melted rocks or metals; and proves that the earth, as a whole, is much more rigid than any of the

rocks which constitute its upper crust." Thus a scientific doctrine, not long ago received as a certain truth, has been entirely reversed and set aside by the further progress of science.

Another theory lately advanced is doomed, I suspect, to a similar fate. I mean the view first propounded, I think, by Mr. Croll, and adopted by Mr. Geikie in his Great Ice Age, and many others, that the supposed long ice-period of geologists can be explained by the changes in the earth's eccentricity. This would amount, by his calculation, to $10\frac{1}{2}$ millions of miles, about 210,000 years ago. Now the precession of the equinoxes, once in twenty thousand years, will place the winter solstice of the northern hemisphere in the aphelion. The combined effect of the two causes, when the winter half of the year was so much longer, exceeding the summer half more than fifty days, is thought enough to explain a long ice-period in the northern hemisphere.

But in this hypothesis almost everything is precarious and uncertain. It is doubtful whether we can at all depend on the calculations of the past amount of the eccentricity. Elements wholly neglected might completely alter the reckoning for a time so long ago. The heating power of the sun, when one-fifth below the mean at the aphelion, would be one-fifth above it in the perihelion. The swiftness and the nearness exactly compensate each other; so that the amount of heat falling on the earth within one degree or minute of longitude is the same in every part of the orbit. Thus for the whole year the total heat which falls on the earth can be scarcely at all affected by the eccentricity, and even the ratio, for either hemisphere, of the total heat received in the summer and the winter half-year, from equinox to equinox, will not depend on the eccentricity, but on the inclination of the axis alone. And so, while variations of the eccentricity could thus have only a slight and secondary effect in a period of successive years, other causes might have a far greater effect, on which no exact data can be given, such as the proportions of land and sea, the varying transparency of the earth's atmosphere, or changes in the absolute heating power of the sun.

A change of views once widely received is also in progress with reference to the distances of the stars and nebulæ, and the structure of the stellar universe. Sir W. Herschel, in his earlier papers, assumed a near equality in the absolute size of the stars, and accounted for their unequal light by unequal distance alone. Hence enormous estimates of the remoteness of the smaller stars and the nebulæ, reaching to sixty or

a hundred thousand years of the journey of light. But since difference of apparent brightness may arise either from real diversity of size or greater distance, the reasonable course, till deciding evidence is obtained, is to share the effect equally between the two causes. On this view the high estimates of thirty, sixty, or a hundred thousand years of light, will reduce themselves to those of 300, 420, and 550 years. Herschel's own discovery of binary and multiple stars did much to set aside the basis of his earlier speculations. The Magellanic clouds yielded further evidence against them. All recent discovery has tended in the same line, to prove that physical relations exist between stars very unequal in size, or stars and nebulæ. The spectroscope is fast completing the same revolution in our view of the stellar universe. And Mr. Proctor has shown in another way that "the brilliancy of stars is no satisfactory criterion of their proximity."

The uncertainties and errors on which I have dwelt belong to physics, and its most advanced and certain portion, astronomy. The same nebulous character must apply still more to geology, where the data are far more complex; and most of all to physiology, and the sciences that deal with life and living creatures. Here the growth of conjectures, claiming the name of science, and falsely so called, has been surprising and prodigious. A whole school of physiologists have arisen, who can persuade themselves, and try to force their own conviction on others, that the many thousand existing or extinct species of animals have been developed out of each other, by gradual change, through intermediate forms a thousandfold more numerous. And yet of these millions of subspecies, bridging over the ten thousand intervals of known species, no single specimen now survives, or has been found in the immense number of the actual fossils of geology. Such a view is more like madness reduced to method than the sober and deliberate verdict of reasonable men. But then it relieves those who hold it from the bugbear which alarms and repels them, the need of any special acts of creation by an intelligent Author and Maker of the universe.

Now even in astronomy, where there is the largest nucleus of solid truth, how much remains nebulous and obscure! The law of gravitation has been proved, and more than proved, by the researches of the last two hundred years. But there cluster around it, even now, some of the wildest fancies that ever entered the mind of man. Matter certainly exists; though this is denied by some philosophers, and others balance the error by asserting that nothing exists beside it. But the

views of its true nature are so diverse as almost to bring into doubt the very fact they seek to explain. Ether also exists; though here the doubters have more excuse, and are more numerous. But the contrast and variety in opinions as to its precise nature are greater still. Conservation of energy is a truth, inductively proved within certain limits, and in reference to lifeless matter and ether in all their forms. But some affirm it to be the first of *a priori* truths, far more certain than the Being of God. And they extend it to all living things; which involves the singular doctrine that men and animals must like or dislike all things in a strictly equal degree, whenever they are at the same distance. Others retain in words this creed of the conservation of energy, but replace it really by the counter-doctrine of its ceaseless dissipation and loss. The concussion theory of solar heat has been taken up and abandoned within the last twenty years. The contraction theory is now in vogue, but cannot fail to share the fate of its short-lived predecessor. The molten nucleus theory of the earth's structure has reigned for two or three generations, and is now finally disproved. The astro-glacial theory, born only the other day, has no stamina of life, and will probably die to-morrow. The teaching of the elder Herschel on the distribution of the stars is being fast superseded, through the reasoning of his no less eminent son on the Magellanic clouds, and by other still later discoveries. The words of Cato in Addison apply even to this clearest part of this scientific landscape:

> A wide, unbounded prospect lies before me,
> But shadows, clouds, and darkness rest upon it.

As a general rule, those speak most boastfully of the achievements of modern science who understand them the least; and those impute credulity to Christian believers most freely, who are practising it themselves in a more aggravated form. They will not believe the Scriptures to be really the word of God, though confirmed by miracles and prophecies, and the experience of tens of thousands, who have found them to bring moral strength, and deep and lasting peace to their inmost souls. But they can accept with implicit faith guesses not twenty years old on the supposed state of the earth or sun myriads of years ago, and believe in hundreds of thousands of years of man's existence on the sole evidence of a few cores or scrapers or flakes of flint, assumed to bear marks of human work, and found in strata of indeterminate age; because this opinion is now current, for a few years past, in some scientific

circles. They are part of that unthinking multitude, whom Cowper has described—

> Too weak to bear
> The insupportable fatigue of thought;
> And therefore swallowing, without pause or choice,
> The total grist unsifted, husks and all.

Thus not only uncertain guesses, but, in more cases than one, palpable errors and self-contradictions have been enshrined in their new Pantheon as certain and axiomatic truths.

"Many shall run to and fro, and knowledge shall be increased." This voice of God to Daniel, spoken two thousand four hundred years ago, was chosen by Lord Bacon for the motto of his great work, and has been signally verified in our own days. Railways, steamboats, electric telegraphs, bear witness to the new powers man has acquired, the swift running to and fro of multitudes, and his mastery over the earth on which he dwells. Mountains have been tunnelled, the depths of ocean sounded, the rays of sunlight and starlight analyzed, and isthmuses traversed by the fleets of the world. Eclipses and transits, predicted to a second, show the perfect knowledge he has gained of the heavenly motions. The spectroscope is bringing hourly within our reach, in the depths of the firmament, much that until of late was thought inaccessible. The change is in progress still. And what is the revealed purpose and issue of this growth of natural science? God is enlarging the base and pedestal, on which to rear a glorious building of moral and spiritual truth. The knowledge of nature is linked inseparably with the knowledge of man. Man cannot be known aright without the knowledge of his Creator and Sovereign. This threefold cord can be neither untwisted nor broken. It is of God's own framing, and cannot be sundered by the hands of men.

It has been said poetically of the ocean, that "his great bright eye most silently up to the moon is cast." With still more truth it may be affirmed—all Nature looks upward and points upward to the throne of God. Creation is a vast storehouse of types of heavenly truth, and is full of secret prophecies of the good things to come. The heavens and earth can never be measured and weighed aright, without leading to the knowledge of Him who "telleth the number of the stars, and calleth them all by their names"; who metes the ocean as in the palm of his hand, and weighs the mountains in scales, and the hills in a balance. Life can never be studied

aright, or its true nature and laws discerned, apart from Him who is the Lord and the Giver of Life, who breathed it into man's nostrils in the hour of his birth, and whom truly to know is life eternal. As a general rule, the chief discoverers in Natural Science have been Christians of a modest, reverent, and religious tone of mind. Copernicus, Kepler, Bacon, Boyle, Pascal, Newton; and in the past and present century, Euler, Cavendish, Cuvier, Brewster, Sedgwick, Whewell, Faraday, have all combined ardour in physical research with a spirit of reverence for Christian truth. They have entered into Bacon's prayer, that no unlocking of the secrets of nature may cause blindness to the higher mysteries and messages of the word of God; and the axiom of Newton, that the object of physics is to trace phenomena up to their causes, climbing to those more and more simple and general, "till we come to the First Cause, which is certainly not mechanical."

For myself, I can see no cause whatever for alarm to the Christian in the growth of what calls itself scientific disbelief. The divorce of physics from Christian faith and piety may be permitted for a moment, but it can never last. There is no science, but the extreme of folly, in the Atheist creed, that trillions of atoms were their own creators, that each chose for itself, in the moment of its birth, where it should pitch its ever-moving tent, and whether it should be an atom of matter or one of ether, and endued itself further with the promise and potency of every form of life that exists in the depths of ocean, on earth, or in heaven. I have no faith even in the desponding Theism which holds that the sun is a spendthrift and a prodigal, wasting nearly all its light and heat in riotous living, losing it in empty space, and is thus doomed justly, after a few millions of years, to utter bankruptcy, and eternal, midnight darkness. But of one thing we may be sure without the shadow of a doubt. The Sun of Righteousness, in His deep compassion and love, once suffered eclipse for a moment. But that hour of brief darkness is past, and can never return. He must reign, till all be subdued unto Him in heaven and in the earth. He must and will shine, and shine on for ever. The chiefs and leaders of science then only occupy their true place, and fulfil aright their appointed office, when they copy the heavenly elders, cast down their meaner chaplets and coronets before the throne of the Most High, and take up with heart and voice that celestial song of praise—"Thou art worthy, O Lord, to receive honour, and glory, and power; for Thou hast created all things, and for Thy pleasure they are, and were created."

Since these remarks were penned, I have seen in the *Revue des Deux Mondes*, of May 15, the following note to an able article on recent solar discoveries :—

"The apparent analogy of this double belt of spots, which extends on one side and another of the solar equator, with the terrestrial zone of the trade winds has led Sir J. Herschel and M. Spoeren to suppose the existence of winds of the same kind at the surface of the sun. But the theory of solar trade winds wants any serious foundation, for one does not see what could produce on the atmosphere of the sun a circulation like that which is the cause of terrestrial winds.—"La Constitution de Soleil," note 2 p. 445.

The view here set aside, because the writer "does not see" any serious ground for it, is precisely the same which I have stated, to result from the laws of dynamics, applied to a joint system of matter and self-repulsive ether; and which has thus the sanction of two of the foremost names in general astronomy and spectroscopy, from direct observation of the solar phenomena alone.

ANNUAL GENERAL MEETING,

HELD AT THE HOUSE OF THE SOCIETY OF ARTS,

Monday, May 29, 1876.

The Right Honourable the Earl of Shaftesbury, K.G., President, in the Chair.

The Honorary Secretary, Capt. F. Petrie, read the following Report :—

TENTH ANNUAL REPORT of the Council of the Victoria Institute, or Philosophical Society of Great Britain.

Progress of the Institute.

1. In presenting the Tenth Annual Report, the Council desires to state that the progress of the Society, due in no small degree to the personal interest taken in its welfare by those who have become its supporters, has been such as to encourage the hope that it may speedily be adequately powerful to undertake all it was designed to accomplish; but that this hope may be realized, it is not the less necessary that those efforts which have placed it in its present position should not be relaxed. The average increase of Members and Associates during the past five years has been upwards of one hundred annually, and the actual number of additional names has slightly increased each year. Such progress has greatly contributed towards making the objects of the Society more widely known, and its work more telling.*

* During the year, 1875, 115 Members and Associates have joined (18 being foreign, 64 country, and 33 resident in town).

2. The election of the Vice-Presidents and Council has been carried out in accordance with the proposition agreed to at the 1874 Annual Meeting, namely, by voting-lists being forwarded to the members. The following have been elected:

President.—The Right Honourable the Earl of Shaftesbury, K.G.

Vice-Presidents.

The Right Honourable the Earl of Harrowby, K.G.
Philip Henry Gosse, Esq., F.R.S.
Charles Brooke, Esq., M.A., F.R.S., P.R.M.S., &c.
Rev. Robinson Thornton, D.D. — C. B. Radcliffe, Esq., M.D., &c.
W. Forsyth, Esq., Q.C., LL.D., M.P. — Rev. Principal T. P. Boultbee, LL.D.

Hon. Treasurer.—William Nowell West, Esq.

Hon. Sec. and Editor of Journal.—Capt. F. W. H. Petrie, F.G.S., F.R.S.L., &c.

Council.

Robert Baxter, Esq. (*Trustee*).
Rev. A. De la Mare, M.A.
Rear-Admiral E.G. Fishbourne, R.N., C.B.
R. N. Fowler, Esq. (*Trustee*).
William H. Ince, Esq., F.L.S., F.R.M.S.
Alex. M'Arthur, Esq., M.P.
Edward J. Morshead, Esq., H.M.C.S. (*Hon. Foreign Sec.*).
Alfred V. Newton, Esq.
William M. Ord, Esq., M.D.
S. D. Waddy, Esq., Q.C., M.P.
William Vanner, Esq., F.R.M.S.
Alfred J. Woodhouse, Esq., F.R.M.S.
Rev. J. H. Rigg, D.D.
Rev. Prebendary Row, M.A.
Rev. Canon Titcomb, M.A.
J. A. Fraser, Esq., M.D., I.G.H.
Rev. Charles Graham.
T. W. Masterman, Esq.
H. Cadman Jones, Esq., Barrister-at-Law.
Rev. J. G. Wood, M.A., F.L.S., &c.
Rev. W. Arthur, D.D.
C. R. Bree, Esq., M.D., F.Z.S.
John Eliot Howard, Esq., F.R.S.
Rev. G. W. Weldon, M.A., M.B.
Rev. Principal J. Angus, M.A., D.D.
J. Bateman, Esq., F.R.S., F.L.S
The Master of the Charterhouse.

3. The library has received several valuable additions through the generosity of members.

4. The Council regrets to announce the decease of the following valued supporters of the Institute:—

The Rev. Prebendary E. B. Elliott (Member); T. Ensor, Esq. (Foundation Associate); the Rev. G. Lawless, M.A. (Associate); the Ven. Archdeacon Long, M.A. (Member); P. McFarlane, Esq. (Foundation Life Member); W. Foster Newton, Esq. (Member); S. H. Smith, Esq. (Associate); the Ven. Archdeacon Stanton, M.A. (Member); the Rev. J. Williams, M.A. (Foundation Associate).

5. The following is a statement of the changes which have occurred during the past twelve months :—

	Life Members.	Life Associates.	Annual Members.	Annual Associates.
Numbers on 1st June, 1875	29	13	294	248
Deduct deaths ...	1	—	4	4
	28		290	244
Withdrawn	—	—	9	14
			281	230
Joined between June 1st, 1875, and May 1st, 1876	2	1	46	67
	30	14	327	297
	44		624	
Total			668*	

Hon. Foreign Correspondents and Local Secretaries, 13.

Finance.

6. The Audited Balance Sheet of the Treasurer for the year ending 31st December, 1875, is appended, showing a balance due to the Treasurer of £14.† It will be observed that the Balance Sheet is no longer divided under two heads ("General Account," and "Special Fund for Library," &c.). The total amount now invested in the New Three per Cent. Annuities is £666. 0s. 1d.

7. The arrears of subscription are now as follows :—

	1872.	1873.	1874.	1875.
Members	1	3	3	6
Associates.....	1	1	3	11
	2	4	6	17

* Joined during May, 3 Members and 6 Associates ; total, 677, and 13 = 690. The total number on the 1st of January, 1871, was 201.

† It should be noted that the sum of £71. 11s. was due to the Society from various Members and Associates on account of unpaid subscriptions for the year 1875 ; all but £23. 4s. of this has since been paid. (*See* sect. 7.)

8. The estimated ordinary assets of the Institute for the current year, exclusive of arrears and of new subscribers, are as follows:—

Annual Subscribers.	£.	s.
327 Members, at £2. 2s.....	681	14
297 Associates, at £1. 1s.....	311	17
Vice-Patrons, Life Members, and Life Associates. (Dividend on £666. 0s. 1d. Three per Cent. Stock) ..	18	11
Total.....	£1012	2

Meetings.

9. The following is a list of the papers for the present session, viz.:—

"On Present Day Materialism." Rev. J. McDougall. December 6, 1875.

On Scepticism." By the Rev. Robinson Thornton, D.D., V.P.; being the Fourth and concluding portion of the Arguments brought forward in the Author's Papers on "The Logic of Scepticism," "The Credulity of Scepticism," "The Varying Tactics of Scepticism," read in 1866, 1869, and 1874. The present Paper will be entitled "The Sorrows of Scepticism." January 3, 1876.

An Examination of a work entitled "The Unseen Universe, or Physical Speculations on a Future State"; its Scientific Conclusions and Theological Inferences. By Rev. Prebendary W. J. Irons, D.D. January 17.

"On Heathen Cosmogonies compared with the Hebrew." By Rev. B. W. Savile. February 7.

"On Traces of early Phœnician, Jewish, and Carthaginian Intercourse wi the British Isles." By F. A. Allen, Esq. February 21.

"The Horus Myth." By W. R. Cooper, Esq., Sec. Soc. of Biblical Archæology. March 6.

On "A Critical Examination of the Flint Knives from Brixham Cavern." By N. Whitley, Esq., C.E. (With Photographic Illustrations.) March 20.

"Egypt and the Bible." By J. E. Howard, Esq., F.R.S. April 3.

"The Place of Science in Education." By Professor A. Alleyne Nicholso M.D. (St. Andrew's University). April 10.

"The Metaphysics of Scripture." By Professor Challis, F.R.S., F.R.A.S. (Cambridge). May 1.

Anniversary Address. By Professor Birks, Cambridge. (*At the Society of Arts' House, John Street, Adelphi.* May 29.

* On "The Theory of Unconscious Intelligence as opposed to Theism." By Professor MORRIS, M.D., Michigan University. (*At the Society of Arts' House, John Street, Adelphi.*) June 19.

(Extra Meeting) Special Discussion on Rev. Prebendary IRONS' Paper, read January 17th as above. July 3.

10. The meetings during this session have been as well attended as usual, the Anniversary, and the meeting of the 19th of June being held at the House of the Society of Arts, the rooms of the Institute not affording adequate accommodation.

Publications.

11. The Ninth Volume of the *Journal of Transactions* has been issued, and the several quarterly parts for the current year will appear in due course.

12. In the publication of the *Transactions* the Council has continued the practice of printing in full the papers read, and the discussions thereon, so that country and foreign members, although unable to be present at the meetings, may enjoy, as far as possible, the same advantages as those attending them; and in many instances communications in regard to important points not taken up at the meetings have been sent in by country members. These, being added to the *Journal*, have enhanced its value.

13. Lectures (in furtherance of Object V.) have been given in England and Ireland by some of the members, the papers in the *Journal* being the basis of such lectures. One member in a North of England town (noted for the prevalence of scepticism therein) has been giving lectures for some time past, once, and sometimes twice, a week, to audiences of from 1,500 to 2,000. This member reports that he has found in the *Journal* exactly that which he needed for his work, and which he had looked for in vain elsewhere. — The Institute is also indebted to him for a considerable addition to its Library.—In Italy the papers in the *Journal* are translated and published.—In India, the *Journal* has been found valuable in work among the Brahmins.*

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* The late Sir Donald McLeod urged strongly the need of extending the Institute's sphere of action to India, &c. See *Speech at Annual Meeting*, vol. vii. p. 180.

—In America, the *Transactions* are becoming popular; and the impartiality of the mode of carrying out the investigations has attracted attention.

14. The Hon. Local Secretaries have been added to, and their work is being supplemented by, the efforts of other members, and by two supporters of the Institute now making a tour in some of the colonies. Such efforts not only promote the first objects of the Society, and increase its powers of action, but also tend to make the Society, its design, and its publications, more widely known.

15. The "People's Edition."—The vast amount of unsound, and in many cases avowedly infidel, cheap literature on philosophical and scientific subjects, now in circulation, especially in the larger towns of the United Kingdom, induced the Council in 1874 to begin the issue in a cheap form of single copies of some of the papers in the *Journal*; since then six papers have been issued in this form, entitled "The People's Edition." The plan has been carried out, by deciding beforehand upon the paper to be so issued, and, when it was printed for the *Journal*, striking off extra copies upon common paper. For the sale to the public of the "People's Edition" (and of the *Journal* generally) a scheme of bookseller-agents in fifteen leading towns of the United Kingdom, having been matured, has been in full operation since August last: the results have in some cases exceeded anticipation. Nearly half the Institute's accumulated stock of single papers has been issued to these Agents, some of whom have begun to include our publications in their own circulated list of books. Although the profits have been small, by reason of the low scale of prices necessarily adopted for the "People's Edition" when starting the scheme, yet the importance of the step taken will be apparent. Altogether about 20,000 copies of the papers which appear in the *Journal of the Transactions* were published in a separate form during 1875, and the demand for them appears to be increasing.

16. From time to time the Institute receives requests from clergymen, missionaries, Scripture-readers, &c., for grants of the single papers, for circulation amongst certain classes of the population (working-men in manufacturing, mining, and other districts—especially those districts in which lecturers or literature advocating views tending to scepticism are common). The smallness of the "People's Edition" Fund (founded by a non-member) has not allowed of more than

a few such requests being complied with; but should this fund receive further support,* the Institute will be better able to meet any urgent application of the kind.

Conclusion.

17. The good understanding existing between this and other scientific societies continues to increase, and with many of the leading ones at home and abroad, the Institute exchanges Transactions.

18. Finally, the future of the VICTORIA INSTITUTE rests in no small degree with its present supporters; it is most important that it be maintained in a state of thorough efficiency, and the present Members and Associates may greatly contribute thereto by introducing new supporters; more especially such as may take a leading part in carrying out its objects.

19. The Council cannot but feel thankful for the success which has attended the Society's exertions, and the place it occupies in the estimation of those best qualified to judge of its value.

Signed on behalf of the Council,

SHAFTESBURY, *President.*

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* The donation of £50 from Mr. J. E. Howard, F.R.S., to this fund was, according to stipulation, expended in issuing a large edition of his paper on Professor Tyndall's Belfast address.

DONATIONS TO THE ENDOWMENT FUND.

1873.	£.	s.	d.
C. J. Bevan, Esq. (non-member)	10	10	0
C. W. H. Wyman, Esq.	1	1	0
1875.			
Miss Curteis	1	1	0

(*Funded.*)

DONATIONS TO THE LIBRARY FUND.

1869.			
S. Morley, Esq., M.P.	100	0	0
I. Braithwaite, Esq.	25	0	0
R. Mullings, Esq.	10	0	0
Dr. J. H. Wheatley	10	0	0
H. W. Bleby, Esq., B.A.	5	0	0
T. Prothero, Esq.	3	3	0
A. J. Woodhouse, Esq.	3	3	0
W. N. West, Esq.	2	2	0
G. Williams, Esq.	1	1	0
Rev. J. H. Rigg, D.D.	1	1	0
1870.			
Robert Baxter, Esq.	52	10	0
W. McArthur, Esq., M.P.	21	0	0
John Napier, Esq., *Glasgow*	10	0	0
W. Vanner, Esq.	10	0	0
T. W. Masterman, Esq.	5	5	0
S. D. Waddy, Esq. Q.C., M.P.	5	5	0
Charles Brooke, Esq., F.R.S.	5	0	0
Dr. Fraser	5	0	0
Vice-Admiral Halsted (the late)	5	0	0
Rev. C. Kemble, M.A. (the late)	5	0	0
Rev. W. Niven, B.D.	5	0	0
S. Petrie, Esq., C.B. (the late)	5	0	0
Rev. J. H. A. Walsh, M.A. (the late)	5	0	0
Rev. A. De la Mare, M.A.	3	3	0
Rev. R. Thornton, D.D.	3	3	0
A. V. Newton, Esq.	3	0	0
Rev. J. B. Owen, M.A. (the late)	3	0	0
Captain Jasper Selwyn, R.N., *Tring*	3	0	0
Rev. W. H. Bathurst, M.A.	2	2	0
E. Chance, Esq., J.P., *Malvern*	2	2	0
W. H. Ince, Esq.	2	2	0
John Shields, Esq., *Durham*	2	2	0
Rev. G. R. Badenoch	1	1	0
J. Lewis, Esq., R.N., *Southampton*	1	1	0

	£.	s.	d.
Rev. Preb. Row, M.A.	1	1	0
Very Rev. Dean Payne Smith, D.D.	1	1	0
Rev. Canon Titcomb, M.A.	1	1	0
G. C. Harrison, Esq.	1	0	0
W. Payne, Esq.	1	0	0
J. Shaw, Esq., M.D., *Boston*	1	0	0
Rev. C. Skrine, M.A.	1	0	0
1872.			
A. McArthur, Esq.	42	0	0
Admiral Halsted (the late)	2	2	0
1873.			
C. W. H. Wyman, Esq.	1	1	0
1874.			
Right Hon. Lord Shaftesbury, K.G.	20	0	0
Rev. C. A. Belli	1	1	0
J. W. Lea, Esq.	1	1	0
1875.			
A. Woodhouse	3	0	0
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3 Life Members 63 0 0			
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Printing	396	5	0
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Rent to Christmas, 1875	157	10	0
Salaries for Year, Clerk 39 5 0			
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Gas and Oil	4	12	0
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Investments £118. 4s. 2d. New 3 per Cent. Annuities	111	15	0
Library, Books, Bookcase, Repairs, &c. 26 5 6			
Cost of Removing Institute, &c. ... 17 15 5			
	44	0	11
	£1,211	9	0

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Fourth.—To publish Papers read before the Society in furtherance of the above objects, along with full reports of the discussions thereon, in the form of a Journal, or as the Transactions of the Institute.

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PUBLICATIONS.

Since the Inauguration of the Society, on the 24th of May, 1866, the following Papers have been read:—The Quarterly Parts are indicated by the numbers.

In 1866-7.

1. A Sketch of the Existing Relations between Scripture and Science. By the late GEORGE WARINGTON, Esq., F.C.S.
2. On the Difference in Scope between Scripture and Science. By the late C. MOUNTFORD BURNETT, Esq., M.D., Vice-President V.I.
   On Comparative Philology. By the Rev. ROBINSON THORNTON, D.D., Vice-President V.I.
   On the Various Theories of Man's Past and Present Condition. By the late JAMES REDDIE, Esq., Hon. Sec. V.I.
3. On the Language of Gesticulation and Origin of Speech. By Professor J. R. YOUNG.
   On Miracles: their Compatibility with Philosophical Principles. By the Rev. W. W. ENGLISH, M.A.
   Thoughts on Miracles. By the late E. B. PENNY, Esq.
   On the General Character of Geological Formations. By the late E. HOPKINS, Esq., C.E.
4. On the Past and Present Relations of Geological Science to the Sacred Scriptures. By the Rev. Professor JOHN KIRK.
   On the Lessons taught us by Geology in relation to God. Rev. J. BRODIE, M.A.
   On the Mutual Helpfulness of Theology and Natural Science. By Dr. GLADSTONE, F.R.S.
   On Falling Stars and Meteorites. By the late Rev. W. MITCHELL, M.A., Vice-President V.I.

(The above Papers, with the Discussions thereon, and with "Scientia Scientiarum; being some Account of the Origin and Objects of the Victoria Institute," with the Reports of the Provisional Proceedings, and the Inaugural Address by the late Rev. Walter Mitchell, M.A., Vice-President, form Volume I. of the "Journal of Transactions," price One Guinea.)

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5. On the Terrestrial Changes and Probable Ages of the Continents, founded upon Astronomical Data and Geological Facts. By the late EVAN HOPKINS, Esq., C.E., F.G.S.
   On the Credibility of Darwinism. By the late GEORGE WARINGTON, Esq., F.C.S.
   On the Credibility of Darwinism. By the late JAMES REDDIE, Esq., Hon. Sec. V.I.
6. On Utilitarianism. By the late JAMES REDDIE, Esq., Hon. Sec. V.I.
   On the Logic of Scepticism. By the Rev. ROBINSON THORNTON, D.D., V.P.
   Annual Address (On the Institute's Work). By the late JAMES REDDIE, Esq., Hon. Sec. V.I.
7. On the Relations of Metaphysical and Physical Science to the Christian Doctrine of Prayer. By the Rev. Professor JOHN KIRK.
   On Geological Chronology, and the Cogency of the Arguments by which some Scientific Doctrines are supported. (In reply to Professor Huxley's Address delivered at Sion College on 21st Nov., 1867.) By the late J. REDDIE, Esq., Hon. Sec. V.I. (1867-68).
8. On the Geometrical Isomorphism of Crystals, and the Derivation of all other Forms from those of the Cubical System. (6 *Plates.*) By the late Rev. W. MITCHELL, M.A., V.P.

(Forming Volume II., price One Guinea.)

In 1867-8.

9. On the Antiquity of Civilization. By the Rev. Canon TITCOMB, M.A.
   On Life, with some Observations on its Origin. By J. H. WHEATLEY, Esq., Ph.D.
   On the Unphilosophical Character of some Objections to the Divine Inspiration of Scripture. By the late Rev. WALTER MITCHELL, M.A., Vice-President V.I.
   On Comparative Psychology. By E. J. MORSHEAD, Esq., Hon. For. Sec. V.I.
10. On Theology as a Science. By the Rev. A. DE LA MARE, M.A.
    On the Immediate Derivation of Science from the Great First Cause. By R. LAMING, Esq.
    On some of the Philosophical Principles contained in Mr. Bucklo's "History of Civilization," in reference to the Laws of the Moral and Religious Developments of Man. By the Rev. Prebendary C. A. ROW, M.A.
    On the Nature of Human Language, the Necessities of Scientific Phraseology, and the Application of the Principles of both to the Interpretation of Holy Scripture. By the Rev. J. BAYLEE, D.D.

11. On the Common Origin of the American Races with those of the Old World. By the Rev. Canon TITCOMB, M.A.
On the Simplification of First Principles in Physical Science. By C. BROOKE, Esq., F.R.S., &c.
On the Biblical Cosmogony scientifically considered. By late G. WARINGTON, Esq., F.C.S.

In 1868-69.

On Ethical Philosophy. By the Rev. W. W. ENGLISH M.A.
12. On some Uses of Sacred Primeval History. By the late D. MCCAUSLAND, Esq., Q.C., LL.D.
On the Relation of Reason to Philosophy, Theology, and Revelation. By the Rev. Prebendary C. A. ROW, M.A.

(*Forming Volume III., price One Guinea.*)

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